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ABSTRACT

Place-based, or "contextualized," mathematics instruction gives learners the opportunity to see how mathematics is relevant to their lives. Such opportunities are crucial to the success of students in rural settings and may be crucial to the survival of rural communities. For the last half century, schools have educated rural children to believe that opportunity lay elsewhere and that rural people were responsible for the rural experience of failure and decline. Place-based pedagogy attempts, through relevant and authentic context, to reverse both the outmigration of rural youth and the devaluing of rural communities. Placing mathematics in rural contexts presents a challenge because not all "rural culture" is alike. The product, necessarily, will be unique in each circumstance. Several examples of place-based mathematics are presented. In Craig, Colorado, middle-school students conducted a watershed study that involved mathematics in many ways, including statistics. Students learned how mathematics could improve the quality of the Yampa River, thus improving quality of life and economics for the community In Howard, South Dakota, high school seniors surveyed the community to study its cash flow. When published, the results led to changes in community spending habits and sparked a surge in local buying. Other rural students opened stores or created companies. Mathematicians, mathematics teachers, and rural sociologists must work together to promote place-based mathematics education. (Contains 28 references) (SV)

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"Place" Value: The Rural Perspective

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"Place" Value: The Rural Perspective

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"Place" Value: The Rural Perspective

Place affects value. In the decimal system, each "place" differs in value from an adjacent "place" by a power of ten. An eight used as an exponent affects the value of an expression differently from an eight used as a coefficient. The proverbial bird in the hand is worth two in the bush. An umbrella in the closet is of little value when you are out in a rainstorm. Where mathematics is *placed* can also greatly affect its value both to the learner and to the community in which the learning takes place.

For those of us who have chosen mathematics as a profession, the value of mathematics lies in its logic, truth and beauty. For others, it is a language and a way of thinking. For most of the rest of the population, however, the worth of mathematics lies primarily in its utility. In other words, mathematics is valuable because of what it enables us to do. According to the *Principals and Standards for School Mathematics* by the National Council of Teachers of Mathematics (2000), "School mathematics experiences at all levels should include opportunities to learn about mathematics by working on problems arising in contexts outside of mathematics. These connections can be to other subject areas and disciplines *as well as to students' daily lives*" (emphasis added) (pp. 65-66). Of course, these connections can be relevant or contrived, authentic or non-authentic, meaningful or meaningless.

To make such connections *authentic applications* in mathematics instruction offers students the opportunity to see its value for them and their community. While most students seem willing to slog their way through homework and tests, most

American students are not actively engaged in "doing mathematics" and, therefore, not actively engaged in the creation of mathematical understanding. One way to generate this level of active engagement occurs when mathematics is placed in relevant and authentic contexts.

We have a name for mathematics lessons that lack relevant and authentic contexts: "word problems." Growing up with math presented in such irrelevant and inauthentic contexts, generations of students were robbed of the opportunity to see first-hand what mathematics can do—and this cut away at genuine student incentive to learn and understand. New NSF-funded, standards-based mathematics curricula have students solve problems, investigate ideas, and make connections to daily life. Unfortunately, few of these curricula have applications that connect directly to the culture of rural communities (Schultz, 2001).

In many respects contextual teaching and learning supports what effective educators have always done. For example, Howey (1998) claims that contextual learning emphasizes higher-level thinking, knowledge transfer, collecting, analyzing, and synthesizing information and data from multiple sources and viewpoints. Whether you call it place-based, or "contextualized" teaching and learning, or something else, every learner needs the opportunity to see mathematics at work in his or her life. Such opportunities are crucial to the success of students in rural settings and may be crucial to the survival of rural settings.

Mathematics Learning in Rural Contexts

Attaching learning to contexts is not new. John Dewey (1916) argued the importance of context as a critical part of learning. He asserted that from the child's

standpoint, the great waste in school comes from his inability to use the experience he brings from out-of-schooling settings, while on the other hand he is unable to apply in daily life what he is learning in school. Dewey suggested that schools should be connected with the rest of life where students learn by engaging in meaningful activities. That is, the isolation of the school—and its isolation from life--prevents students from connecting their learning to their everyday activities, including work.

While Dewey's ideas are still popular, new terms are coined regularly that refer to similar concepts. In the 1970s the term *experiential learning* was used to describe contextual teaching and learning (Owens & Smith, 2000). Rogers (1969) distinguishes experiential learning from cognitive learning by asserting that experiential learning addresses the needs and wants of the learner rather than the requirements of the task. Learning while doing has been also called *applied learning* in the 1970's and 1980's. More recently, Berns, Erickson, and Klopfenstein (2000) define *contextual learning* as "learning that involves students connecting the content with the context in which that content could be used." They emphasize connecting content with context as a learning process that brings meaning. Smith (2000) states that contextual learning occurs when students "apply and experience what is being taught by referencing real problems and needs associated with their roles and responsibilities as family members, citizens, students, and workers." Rural educators, and specifically the Rural and Community Trust, tout the success of "place-based" curricula that attaches school subjects to local communities (Haas and Nachtigal, 1998; Haleman and DeYoung, 2000; Haskins, 1999; Smith, 2002; Theobald and Curtiss, 2000). Such curricula blend the academic subject

matter with knowledge of community and aims to instill a sense of value of both the academic subjects and the community in which the student studies those subjects.

Authentic context is beneficial for all learners of mathematics, but it is critical for rural learners. Paul Gruchow writes: "Rural children have been educated to believe that opportunity of every kind lies elsewhere and that the last half century's rural experiences of failure and decline has been largely due to the incompetence, or irrelevance, of rural people" (1985). The out-migration of rural people early in the 20th century provided workers for factories in the cities. Extractive industries such as mining and lumbering exploited local populations while simultaneously appropriating control of extremely valuable local resources. Rural education is often accused of being an extractive activity as well. Education is touted as a ticket to elsewhere and the best and brightest are encouraged to leave. Place-based pedagogy and curricula attempts, through relevant and authentic context, to reverse both the out-migration of rural youth and the devaluing of the rural communities in which those students and their parents live.

Placing mathematics in rural contexts presents a real challenge because not all rural "culture" is alike. Rural contexts are different not only across the United States, but also within specific regions. Take Central Appalachia as an example. Within the same geographic area are families living in the fairly populated cities, and families living in highly isolated areas. The experiences, beliefs, and economics of these families can be dramatically different even though they live within 60 miles of each other. Small city schools can be different than small mountainous community schools or large consolidated county schools. Mining communities are very different from agriculturally based communities.

Central Appalachia, defined as the mountainous regions of eastern Kentucky, east Tennessee, southeastern Ohio and all of West Virginia has a culture, not only unique among other parts of the country, but unique among other rural areas. The people of Appalachia hold to a strong sense of family and community. Schooling that is disconnected from the community it serves is not highly valued; learning to work in the community is valued. The region also has the highest poverty and adult illiteracy rates; some of the lowest economic indicators; and one of the least dense populations in the country. Over the past century, the people and land of Central Appalachia have been stripped of many valuable resources.

For communities and regions to survive economically today, mathematics competency must be developed at high levels. For mathematics competency to be developed, it must be valued. According to *Before It's Too Late* (National Commission on Mathematics and Science Teaching for the 21st Century (NCMST, 2000), competency in mathematics is necessary to build an economic base because of "the rapid pace of change in both the increasingly interdependent global economy and in the American workforce" (p. 7). The economies of rural America lag significantly behind those of suburban and metropolitan areas. For example, in 1990, the poverty rate of Central Appalachia was 27 percent below the national average (Appalachian Regional Commission, 2002, http://www.arc.gov).

The median family income in 1990 in rural areas was approximately 75% of the income in metropolitan areas. There are fewer skilled managerial positions and proportionally more laborer and low-skilled jobs in rural areas (Herzog & Pittman, 1995; McGranahan, 1994).

A body of research reveals, for example, that poverty and isolation in rural areas affect the education infrastructure. Through a careful review of research on rural education, Kannapel and DeYoung (1999) and Kannapel (2000) noted a significant conflict within rural schools, particularly in Appalachia, with regard to curriculum, instruction, and assessment. On the one hand, national and state educational reform offers standards for all students and schools. These standards rightfully represent what is necessary to build a strong national infrastructure in mathematics. Because high-stakes accountability of districts, schools, and teachers is often attached to these standards, rural teachers must address them. On the other hand, local communities, which have powerful influences on schools, place higher priority on individual growth and community contributions. Rural teachers are caught in the middle of these conflicting priorities. They must find a balance between recognizing the needs of the community and helping their community understand its needs with regard to mathematics as represented in national standards. They must also help their community realize that a deeper knowledge of mathematics can benefit the community and that mathematical knowledge need not be reserved only for those who wish to leave the community. The social norms of rural areas value place, community, and family over other priorities. Rural families tend to adopt more traditional values like hard work, discipline, and relationships (Haas & Nachtigal, 1998; Nachtigal, 1982; Seal & Harmon, 1995).

Rural residents tend to select low-paying jobs close to family and friends over high-paying jobs some distance away (Seal & Harmon, 1995; DeYoung, 1995). Rural schools tend to be the center of the community (DeYoung & Lawrence, 1995; Herzog & Pittman, 1995, Nachtigal, 1982; Stern, 1994). They tend to be smaller than urban schools

despite 20 years of consolidation efforts (Sher, 1983; Stern, 1994). Rural adolescents often are conflicted about career aspirations because the pursuit of higher education takes them out of the community (Task Force on Teaching and Learning in Poor Communities, 1999).

Place-based pedagogy focusing on authentic context can help students and teachers address the conflicts inherent in living and working in rural communities. Not every lesson needs be place-based, but augmenting any high quality text with local interest can enhance mathematical learning while building strong connections between students and their community and between the school and the community.

Examples of Place-Based Mathematics

Authentic contexts lie just outside the door of every classroom. Using the local place, however, requires sophisticated pedagogical work on the part of the mathematics teacher. In Craig, Colorado, middle school teachers orchestrated unique math-science lessons on the banks of the Yampa River. Working with the Colorado Department of Wildlife, students conducted a watershed study that involved mathematics in many different ways, including statistics. Temperature, alkalinity, and inveterbrate population tests required simple correlational analyses. Students learned how mathematics could improve the quality of the Yampa River, thus improving quality of life and economics for the Craig community.

In Howard, South Dakota, a group of senior high students conducted a local cash flow study that eventually garnered high levels of national attention. Howard, a small town of about 900 residents in rural Miner County, experienced significant decline during the farm crisis of the 1980s. In 1994, a new high school principal asked his staff a

question that school leaders scarcely ever ask: What can we do in this school to help this community? Although most of the teachers were confused, a few saw it as an intriguing intellectual challenge that caused them to look at their jobs in a different way.

Using a $500 minigrant obtained from a local university, a Howard teacher, with the support of the principal, took students on the academic ride of their lives. The students conceived of a way to study the community's cash flow—how much was earned there, where it was spent, and what was purchased. Students conducted town meetings with local business owners, consulted with the county auditor, and engaged in long debates with all stakeholders over the wording on their surveys. It was a courageous undertaking, but the students were never shy about proceeding. They unabashedly asked community members throughout Miner County to reveal the intimate details of their income and spending habits. When the surveys were collected, the students found themselves with a phenomenal 64 percent response rate and an enormous amount of data to analyze. Using sophisticated computer software, the students sorted the data by income level, spending location, spending category, and other parameters. Statistical analyses of the data confirmed that the people of Howard spent most of their income in the larger and more distant cities of Madison, Mitchell, and Sioux Falls.

Student findings were reported in the local newspaper before the school year was out. The community response was little short of amazing. When Howard citizens saw how much they were spending outside the community, they changed their spending habits. They bought much more locally. Revenue from local sales tax began to skyrocket. The county auditor reported that by the end of the summer, annual sales tax projections had already been exceeded. Based on the average number of times a locally

spent dollar will turn over within a community, the county auditor estimated that the students had engineered a $6 million to $7 million infusion into Howard's economy. In Howard, putting mathematics in the context of *their* place allowed students to experience the power of mathematics and use it to make a substantive contribution to their own community.

A small rural school in Alabama created its own computer manufacturing company, using mathematics extensively as a tool for stocking, billing, and accounting. A class of rural Illinois third graders used mathematics to report the results of their community-wide fire alarm testing service. A small school in South Dakota opened a grocery store several years after the last such operation had closed down. A Wisconsin school in which sixth graders opened a bookstore ultimately generated enough profit that the students created a community foundation. In all cases, solid mathematics lessons came with the added benefit of contributing to the well-being of the community.

Next Steps

Placing mathematics in authentic local contexts is not a simple task. It is a process in which the product, by definition, will be unique in each circumstance. Mathematicians, mathematics educators, and for the rural perspective, rural sociologists must work together. Mathematicians are needed to insure that important mathematics is identified and pursued, for example, to see the differential equations in swinging bridges. Sociologists are needed to insure that the local context is correctly understood, represented and respected. Mathematics educators are ultimately responsible for helping teachers develop the pedagogical skills and dispositions necessary to ensure that appropriate mathematics learning takes place.

Research is needed to explore the varying rural effects on mathematics teaching While much can be learned from existing studies on culture and mathematics, little information about the effects of culture in specific rural areas exist. Silver has called this to the attention of the mathematics education research community in his timely editorial, "Attention Deficient Disorder" (2003).

By placing the mathematics in the community, both the mathematics and the place, the community, gain value in the eyes and minds of the students. Mathematics learning and community support for mathematics learning will benefit.

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